

The NASA "Why?" Files
The Case of the
Phenomenal Weather

Segment 3

Hurricane Ichabod has now reached Category II status, and the tree house detectives wonder what it would be like to live through a hurricane. They contact the Juarez family in Miami, Florida, who went through Hurricane Andrew in 1992 and discover that it is not something they want to experience firsthand. The tree house detectives are now more determined than ever to learn where Hurricane Ichabod will make landfall! They visit Dr. D's to learn more about probability and prediction. Dr. D directs them to NASA Langley Research Center and Anita Rapp to learn how satellites track and collect data on hurricanes and other weather phenomenon. Ms. Rapp tells the tree house detectives that they need to visit Dr. Bill Smith to learn about GIFTS, a satellite of the future that will save many lives and millions of dollars in property damage by offering earlier warnings and more accurate predictions of landfall.

Objectives

The students will

- learn how hurricane paths are predicted.
- learn about probability.
- learn how to determine the volume of an irregular shaped object.
- learn that global patterns of atmospheric movement influence local weather.
- learn that gravity is the force that keeps satellites in orbit around Earth.
- understand how satellites orbit the Earth to collect data.
- learn that natural hazards can present personal and societal challenges because incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

Vocabulary

geostationary - a type of satellite that only sees the same portion, a fixed point, of the Earth at all times

GIFTS - an acronym for Geostationary Imaging Fourier Transform Spectrometer

gravity - an attractive force that exists between all objects

momentum - the characteristic of a moving body that is caused by its mass and its motion

polar orbiting - a type of satellite that covers the entire surface of the Earth

predict - to declare in advance, foretell on the basis of observation, experience, or reasoning

probability - a measure of how often a particular event will happen if something such as tossing a coin is done repeatedly and results in any of a number of possible outcomes

satellite - a heavenly body or man-made object orbiting another of larger size

tornado - a violent, destructive whirling wind accompanied by a funnel-shaped cloud that moves in a narrow path over the land

Video Component

Implementation Strategy

The NASA "Why?" Files is designed to enhance and enrich the existing curriculum. Two to three days of class time is suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 3 of *The Case of the Phenomenal Weather*, discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA "Why?" Files web site and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 2. Use tools located on the web, as was previously mentioned in Segment 1.
4. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the show to answer the questions. An icon will appear when the answer is near.
5. What's Up? Questions—Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the web site ahead of time for students to copy into their science journal.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the*



Careers

weather observer
 tornado observer
 tornado chaser
 climatologist

Phenomenal Weather in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about weather and tropical storms. Organize the information, place it on the Problem Board, and determine whether any of the students' questions from Segment 2 were answered.
4. Decide what additional information is needed so the tree house detectives can predict if the weather will keep them from going to the physics fair and/or Florida. Have students conduct independent research or provide students with information as needed. Visit the NASA "Why?" Files web site for an additional list of resources for both students and educators.
5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
6. If time did not permit you to begin the web activity at the conclusion of Segments 1 or 2,

refer to number 6 under "After Viewing" (p. 13) and begin the Problem-Based Learning activity on the NASA "Why?" Files web site. If the web activity had begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, Problem-Based Learning activity:

Research Rack - books, internet sites, and research tools

Problem-Solving Tools - tools and strategies to help guide the problem-solving process.

Dr. D's Lab - interactive activities and simulations

Media Zone - interviews with experts from this segment

Expert's Corner - listing of Ask-An-Expert sites and biographies of experts featured in the broadcast

6. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon, as suggested on the PBL Facilitator Prompting Questions instructional tool found in the educator's area of the web site.
7. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. Visit the Research Rack in the tree house, the online PBL investigation main menu section "Problem Solving Tools," and the "Tools" section of the Educator's area for more assessment ideas and tools.

Resources

Books

Brandley, Franklyn M.: *Tornado Alert*. Harper Trophy, 1990, ISBN: 0064450945.

Hood, Susan: *The Weather Channel: Hurricanes!* Simon Spotlight, 1998, ISBN: 0689820178.

Petty, Kate: *I didn't know that people chase twisters and other amazing facts about violent weather*. Copper Beech Books, 1998, ISBN: 076130715X.

Rose, Sally: *The Weather Channel: Tornadoes!* Simon Spotlight, 1999, ISBN: 0689820224.

VanCleave, Janice: *Gravity*. John Wiley and Sons, Inc., 1993, ISBN: 0471550507.

Wallner, Alexandra: *Sergio and the Hurricane*. Henry Holt & Company, 2000, ISBN: 0805062033.



Web Sites

FEMA for Kids

This web site is filled with games, student artwork, activities, and cutting-edge graphics that deliver a serious message of disaster preparedness and mitigation for youngsters preschool through eighth grade.

<http://www.fema.gov/kids/>

Red Cross Hurricane Safety Site

Explore this web site to learn what a "watch" and a "warning" mean, prepare a personal evacuation plan, learn what to do before, during, and after a hurricane, and much more.

<http://www.redcross.org/services/disaster/keepsafe/readyhurricane.html>

Weather Channel Hurricane Safety

Great site to learn all about hurricanes and how to prepare for an approaching storm.

<http://www.weather.com/safeside/tropical/>

GIFTS

Visit this web site to learn more about the future of the GIFTS satellite.

<http://danspc.larc.nasa.gov/GIFTS/sci.html>

NASA Langley Research Center's Atmospheric Sciences

Explore this web site to learn more about various current and future satellites and projects being developed by NASA Langley Research Center.

<http://asd-www.larc.nasa.gov/ASDhomepage.html>

Activities and Worksheets

In the Guide

The Probability Factor

An activity to better understand that probability is a way of measuring the chance that something will happen.43

Around and Around It Goes. Where It Will Stop? Do We Know?

An activity to learn how predictions are made.44

Going Down Anyone?

An activity to observe the force of gravity.45

3-2-1 Blast Off!

Learn how satellites are placed in orbit.46

The Fear Factor

Play a game to learn how natural hazards can have significant costs.47

Answer Key

.....50

On the Web

Turn Up the Volume

Use this activity to determine the volume of irregularly shaped objects

Surging Storm

Understand the effect of storm surge during a hurricane



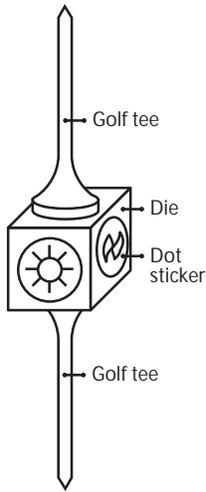
The Probability Factor

Purpose

To understand that probability is a way of measuring the chance of something happening

Procedure

1. To make a probability tester, glue two golf tees opposite each other on a die.
2. Draw the symbol for a hurricane on one of the dot stickers.
3. Repeat with each of the other dot stickers for a tornado, the Sun, and a cloud.
4. Place the dot stickers on the remaining die faces.
5. Predict how many times each face will land on top for the first trial and record in the data chart below.
6. Spin the probability tester and observe which face of the die is on top.
7. Record in the data chart below.
8. Repeat for 9 more spins.
9. Repeat steps 5-7 for 50 spins.
10. Repeat steps 5-7 for 100 spins.
11. Create a class chart combining the data from all groups.
12. Discuss the results.



Materials

- 2 golf tees
- die
- 4 dot stickers
- pencil
- glue (super glue works best)

Data Chart

Trials	Hurricane	Tornado	Sun	Cloud
10 spins	Prediction:	Prediction:	Prediction:	Prediction:
	Actual:	Actual:	Actual:	Actual:
50 spins	Prediction:	Prediction:	Prediction:	Prediction:
	Actual:	Actual:	Actual:	Actual:
100 spins	Prediction:	Prediction:	Prediction:	Prediction:
	Actual:	Actual:	Actual:	Actual:

Conclusion

1. How many faces does the probability tester have?
2. What is the chance of any one face landing upright? Explain.
3. When a class chart was created, did a pattern begin to show?
4. In predicting the probability of landfall for a hurricane, a meteorologist uses many tools to try to get the most accurate prediction he/she can. Research how meteorologists predict landfall and write a short paper describing the process.

Extensions

Cyclone Game

1. Play the Cyclone Game in groups of 2-4.
2. Give each student 15 tokens or beans.
3. Each player puts one token in the center.
4. The youngest player will begin by spinning the probability tester.
5. Observe which symbol is facing up and follow these rules:
 Cloud—takes no tokens Hurricane—takes all tokens
 Tornado—takes half of the tokens Sun—puts in two tokens
6. Continue playing with the player on the left.
7. When one person has won all tokens, the game is over.

Around and Around It Goes. Where Will It Stop? Do We Know?

Problem To understand how to make a prediction

- Procedure**
1. Sit opposite your partner with a large, flat surface between you.
 2. Predict how the ball will travel when rolled to your partner. Will it travel in a straight line or will it curve? If so, which way will it curve?
 3. Roll the ball and observe.
 4. Record your observation by drawing the path your ball took.
 5. Now, carefully observe the flat surface and the surface of the ball. Discuss any feature that might have affected the ball as it rolled across the surface— dirt, scratches, smoothness, and so on.
 6. Predict the path of the ball and roll it to your partner again.
 7. Observe and record.
 8. Repeat steps 2-7, having your partner roll the ball to you.

Materials
flat surface (floor or table)
small ball or marble
science journal
pencil

- Conclusion**
1. Did the ball always roll in the same path? Explain why or why not? _____

 2. How did observing the flat surface and the ball help you predict the ball's path? _____

 3. Did your partner's ball roll the same way as your's? Why or why not? _____

 4. When predicting the path of a hurricane, what factors would a meteorologist consider? _____



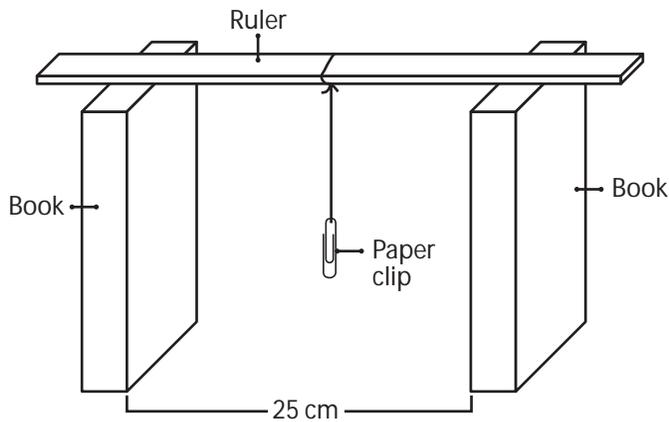
Going Down Anyone?

Problem To observe the force of gravity

- Procedure**
1. Tie the paper clip to one end of the string.
 2. Tie the other end of the string to the center of the ruler.
 3. Stand the two books on a flat surface approximately 25 cm apart.
 4. Lay the ruler across the tops of the books as shown in the diagram.
 5. Observe the position of the string and paper clip.
 6. Record in your science journal by drawing what you see.
 7. Lift one end of the ruler about 10 cm above the top of the book.
 8. Observe and record.
 9. Discuss the results.

Materials

- ruler
- 30-cm string
- 2 books of equal size
- paper clip
- science journal
- pencil



- Conclusion**
1. Did the position of the string change when you lifted the ruler? _____
 2. Explain what happened. _____



3, 2, 1...Blast Off!

Problem

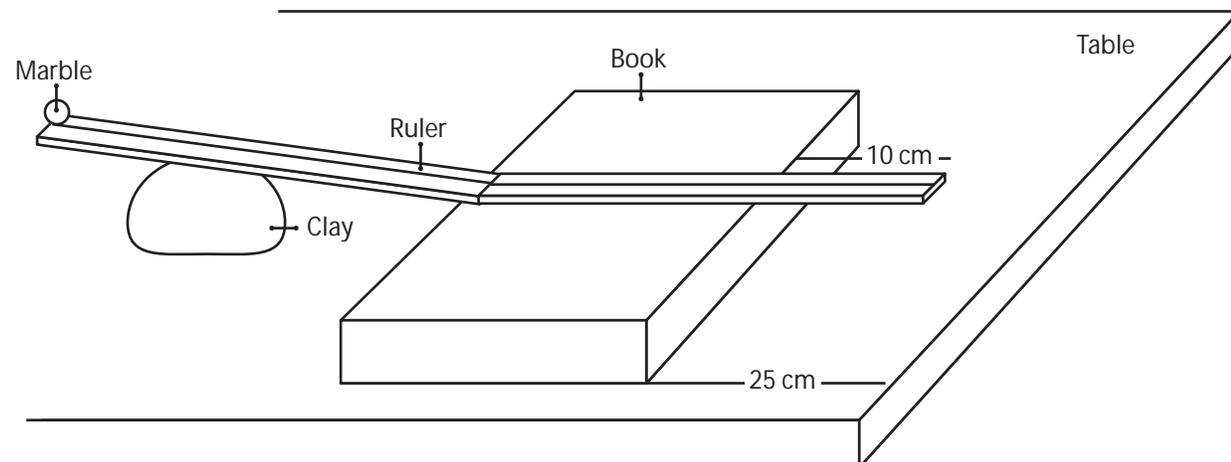
To understand how satellites are placed in orbit

Procedure

1. Position the book about 25 cm from the edge of the table, which represents the Earth.
2. Place one ruler on top of the book with 10 cm of the ruler extending over the edge of the book.
3. Place the second ruler so that one end touches the end of the other ruler with the grooves of the rulers lined up.
4. Raise the other end of the ruler about 5 cm above the book and hold it in that position by placing a clay ball underneath the ruler.
5. Place the marble, which represents a satellite, at the top of the raised ruler and let go.
6. Observe the path of the marble.
7. Launch your satellite several more times.
8. In your science journal, draw and describe your observations.

Materials

large book or cardboard box
2 plastic rulers with center groove
marble
clay
flat table surface
science journal
pencil



Conclusion

1. Was the path of the marble a straight line or a curved line? _____
2. Explain why the marble did not fall straight down to the floor. _____

3. What force is pulling the marble down toward the floor? _____
4. When a satellite is launched into space, how does it overcome this force? _____

5. What keeps a satellite from falling back to Earth? _____



The Fear Factor

Purpose

The students will learn that natural hazards present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

Teacher Prep

To make the spinners:

1. Cut out the circles and place them on top of the cardboard.
2. Trace around each circle and cut out the cardboard.
3. Glue each spinner to a cardboard circle.
4. Using the tip of the scissors, punch a hole in the center of the circle.
5. Cut out the arrows and punch a hole in the end as indicated.
6. Using a brad, connect the arrow to the spinner.
7. Cut out the hurricane disk.

Teacher Note To make playing the game easier, place the game board on a piece of cardboard and use a pushpin to hold the hurricane disk in place.

Materials

spinners (p. 48)
game board (p. 49)
cardboard
scissors
glue
2 brads
die
play money (p. 48)
hurricane disk (p. 48)
game pieces (p. 48)
pushpin

Procedure

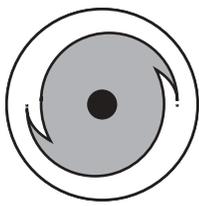
2-4 players

1. Determine who will be the following: banker, meteorologist, and Hurricane Hunter.
2. Roll the die to determine which house is your designated house. If you roll a number that has already been taken, continue to roll until you get one that has not yet been taken.
3. The banker will give each player \$500 to start the game.
4. Place the hurricane disk at the start point on the game board. The hurricane begins as a category I hurricane.
5. The meteorologist spins the direction spinner to determine the direction that the storm will move and moves the disk one square in the indicated direction. For NE, SE, SW, and NW, move diagonally. Each spin represents one day.
6. The Hurricane Hunter will spin the category spinner to determine the category of the storm.
7. Each player will decide what to do about his or her house according to the movement and intensity of the storm. Follow the guidelines below:
Stay and do nothing: receive \$100 in pay for another day worked.
Prepare and stay: pay \$200 for the day lost at work and the cost of preparing your home.
Prepare and evacuate: pay \$100 for preparing your home plus a \$100 each day you are evacuated.
Evacuate: pay \$200 for each day you are evacuated.
8. Continue to play the game until the hurricane makes landfall. Follow the guidelines below:
If you are within two squares of landfall:
If you stayed and did nothing: pay \$500 If you prepared and stayed: pay \$200
If you prepared and evacuated: pay nothing If you evacuated but did not prepare: pay \$300
If you are within three squares of landfall:
If you stayed and did nothing: pay \$300 If you prepared and stayed: pay \$100
If you prepared and evacuated: pay nothing If you evacuated but did not prepare: pay \$200
If you are within 4-6 squares of landfall: pay \$200
If you are within 7 or more squares of landfall or if the storm decreases below a category 1 hurricane, there are no charges.
9. The player with the most money at the end of the game wins.

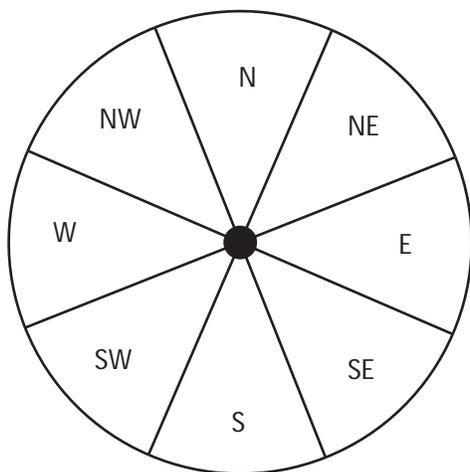
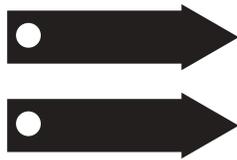
The Fear Factor

Conclusion

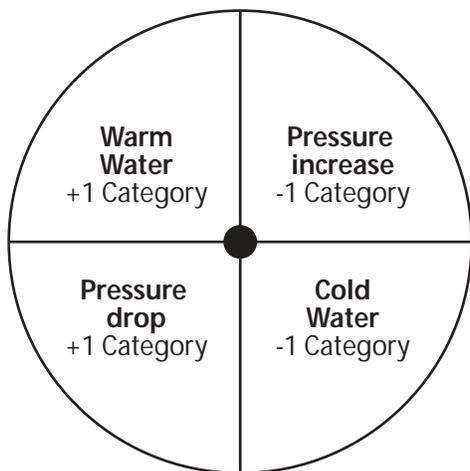
1. What factors influenced your decisions about preparing for the hurricane?
2. Can you ever accurately predict what a hurricane will do? Why or why not?
3. For every mile of coastline evacuated, the price paid is approximately \$1 million. Knowing the cost to evacuate, would you be more cautious in issuing watches and warnings if you were the meteorologist? Why or why not?
4. What is the probability for the storm to move North?
5. What is the probability for the storm to increase in strength?



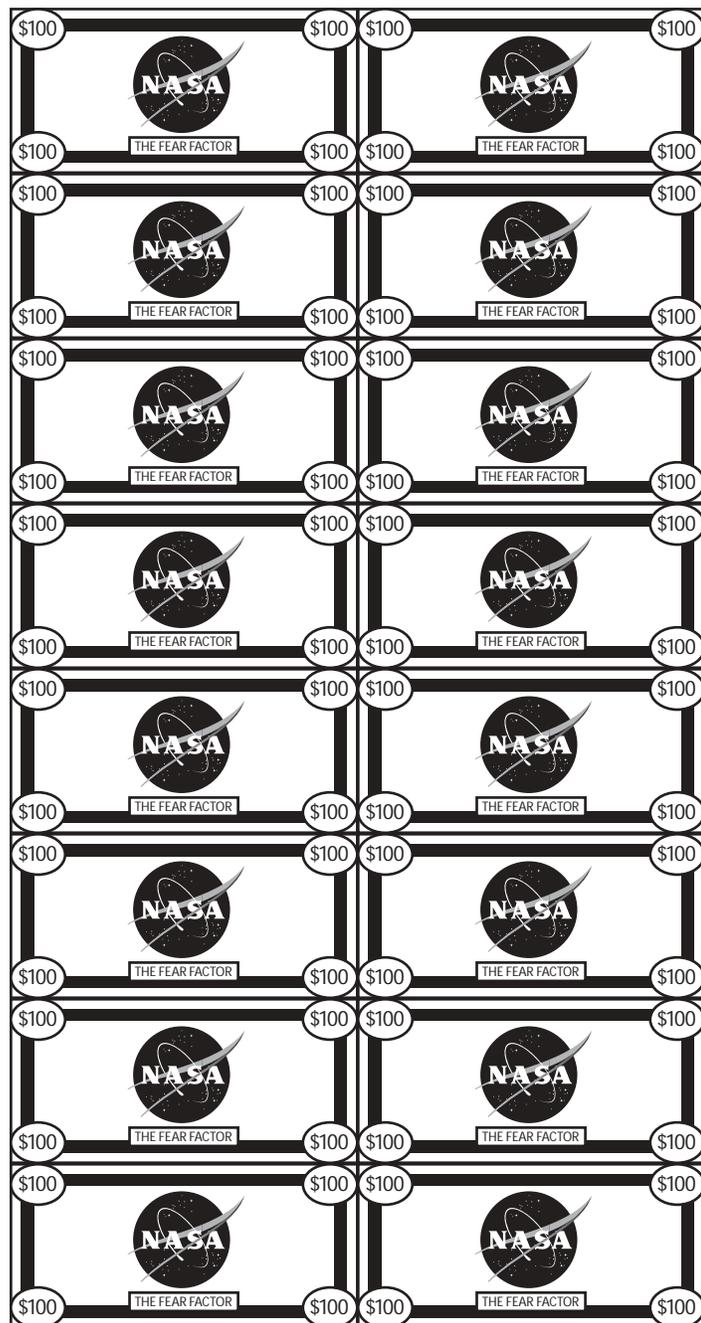
Hurricane Disk



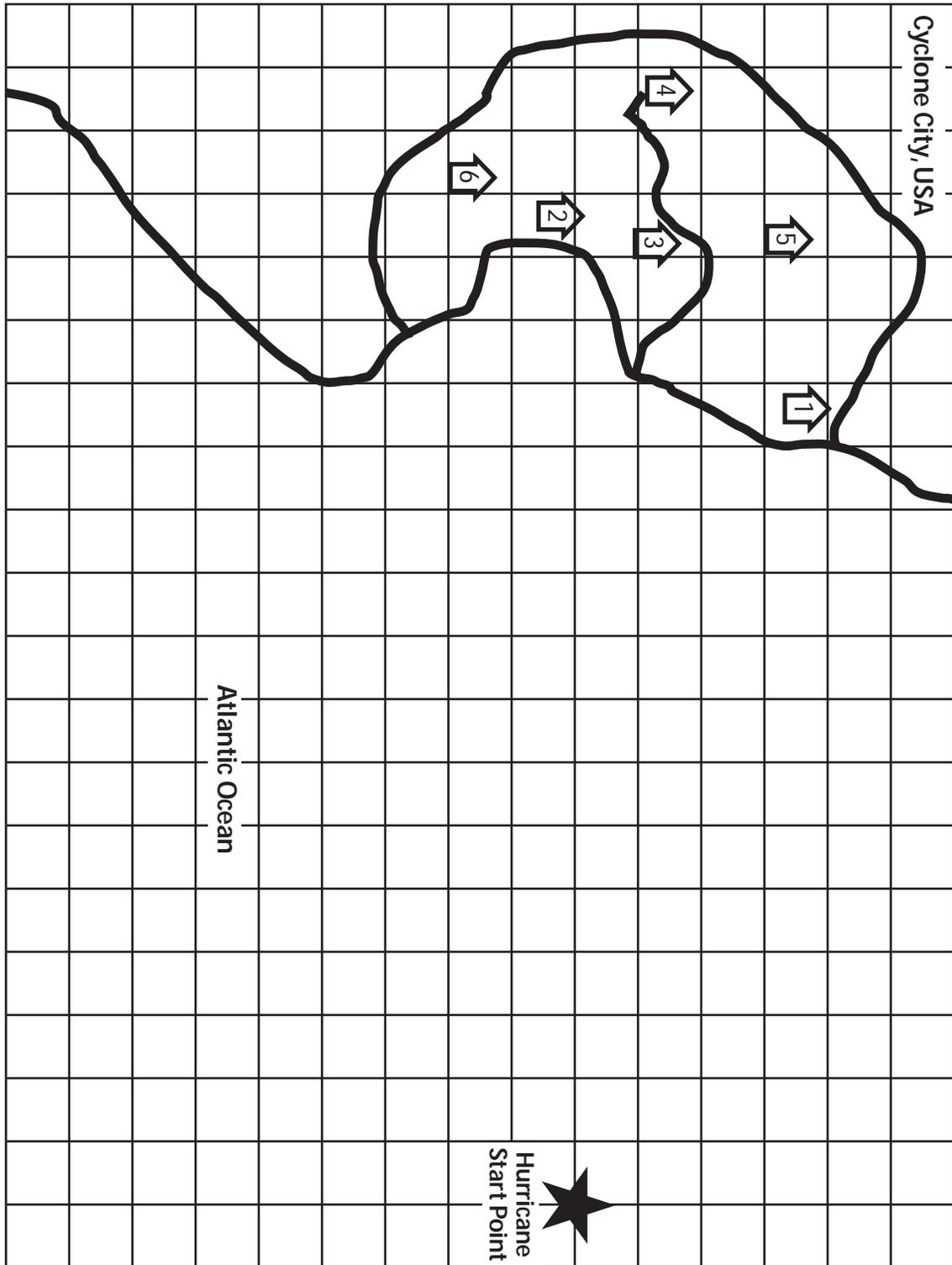
Direction Spinner



Category Spinner



The Fear Factor Game Board



Answer Key

The Probability Factor

1. The die has six faces, but two are covered with the golf tees. That leaves four remaining faces.
2. The chance of any one face landing upright is one in four. If you spin the tester, you have the chance of any one of the four faces landing upright, but only one can, so you have a one in four chance.
3. When the class combines each group's data, the sample data becomes larger, and a pattern may begin to emerge. However, even 500 spins is still a relatively small number of spins in probability.
4. Answers will vary but might include computer models, paths of previous hurricanes that formed in the same area, and current weather data.

Around and Around It Goes.

Where It Will Stop? Do We Know?

1. Most likely, the ball did not always roll in the same path. There are many variables that can affect the path of the ball. Some of the variables may include dirt, small grooves, scratches, or uneven areas on the table or floor. The ball may also have a seam, bump, or dirt on it.
2. By observing the surface of the table or floor and the ball, you are better able to see the variables that would affect its path. For example, if the floor had a deep scratch in it, you would know not to roll the ball across it.
3. Your partner's ball probably did not roll in the same path as your ball. Even though the same variables were present, they were in reverse order.
4. Meteorologists have to consider many variables such as high- and low-pressure systems and their location, the temperature of the water, the path of previous hurricanes, upper atmospheric winds, and so on.

Going Down Anyone?

1. The position of the string did not change when the ruler was lifted.
2. The pull of the Earth's gravity is always downward toward the center of the Earth. No matter at what angle the surface is, gravity pulls objects toward the center; therefore, the positions of the string and paper clip were the same.

3-2-1 Blast Off!

1. The path was a curved line.
2. The marble did not fall straight down because its launching speed pushed it forward.
3. Gravity is the force pulling it downward.
4. The closer an object is to the Earth, the stronger the pull of gravity. A satellite has booster rockets that help it get high enough above the surface of the Earth so that the pull of gravity is not as great.
5. Once a satellite is placed in orbit around the Earth, it will continue to fall in a curved path, but its forward speed is great enough to overcome the pull of gravity. Its forward speed and the pull of gravity keeps a satellite away from the Earth's surface and moving in a curved path.

The Fear Factor

1. Answers will vary but should include the distance of the storm from landfall, strength of the storm, and location of house.
2. No, you cannot accurately predict the path or strength of a hurricane. There are too many variables that enter into the equation, and it is impossible to know each one and how it will affect the storm.
3. Answers will vary. Students should understand that even though the cost to evacuate is high, human life is more valuable than property.
4. The probability is one to eight (1:8).
5. The probability is two to four (2:4) or one to two (1:2).

